Lower Selway Slough

Base Level Hydraulic Analysis and Floodplain Mapping Report

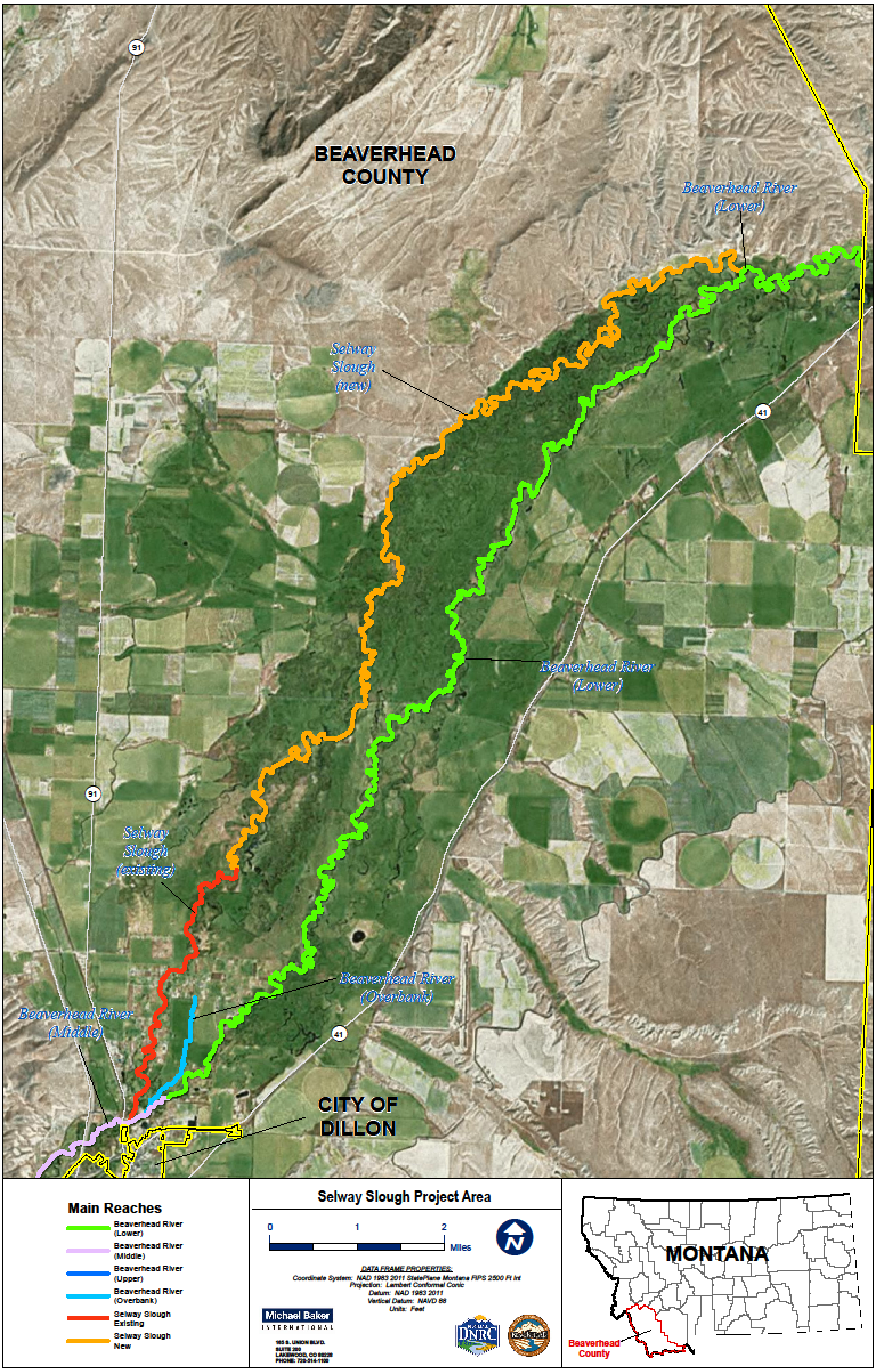
Beaverhead County, MT

October 2018

Michael Baker INTERNATIONAL

Table of Contents

Figure 1: Selway Slough



1. Introduction

Under contract to the State of Montana's Department of Natural Resources and Conservation (DNRC), Michael Baker International (Baker) has been tasked with performing an base level hydraulic analysis for Lower Selway Slough. The purpose of this hydraulic analysis is to provide new and updated hydraulic information that will be used to create approximate (Zone A) floodplain mapping in the Selway Slough area. The State of Montana is a Cooperating Technical Partner (CTP) with the US Department of Homeland Security (DHS) Federal Emergency Management Agency (FEMA).

This hydraulic analysis covers Selway Slough from the end of the detailed hydraulic study performed by Baker as a part of the Beaverhead River hydraulic analysis (approximately 1.4 miles downstream of Lost Trail) to Selway Slough's confluence with the Beaverhead River (Figure 1). The approach to this hydraulic study is a base level 2-D analysis, which captures flow splits and alternate flow paths for the entire reach. The total study reach is approximately 18 miles.

There is no effective floodplain analysis for this reach of Selway Slough. The effective Flood Insurance Rate Maps (FIRMs) show this area as Zone D – area subject to possible but undetermined flood hazards.

2. Beaverhead River Study

The source of Selway Slough is its divergence from the Beaverhead River. Therefore, this study is related to Beaverhead River and Tributaries Hydraulic Analysis (Reference 1), which is currently being completed by Baker. The Beaverhead River hydraulic analysis includes approximately 4.9 miles of detailed study on Selway Slough, from its divergence from the Beaverhead River to approximately 1.4 miles downstream of Lost Trail. It also includes the Beaverhead River itself, through and beyond the confluence with Selway Slough.

2.1. Selway Slough Discharge Calculations

Discharge calculations for this base level hydraulic analysis on Lower Selway Slough are based on information from two sources: the Beaverhead River Hydrologic Analysis, completed by Pioneer Technical Services in April 2017 (Reference 2), and the Beaverhead River and Tributaries Hydraulic Analysis, currently being completed by Baker.

Flow on the Beaverhead River was determined by gage analysis. The 1%-annual-chance flow on the Beaverhead at the location where Selway Slough diverges is 1,960 cfs. On the left bank of the Beaverhead River, a diversion structure takes flow from the Beaverhead River (Figure 2). A non-levee embankment is also present.

Figure 2: Selway Slough Diversion Structure

Flow on Selway Slough was determined using hydraulic methods as a part of the Beaverhead River and Tributaries Hydraulic Analysis. In addition to calculating the flow through the diversion structure itself, a “worst case scenario” analysis was also performed on the non-levee embankment. The 1%-annual-chance flood event on Selway Slough occurs when the non-levee embankment fails between Highway 91 and Selway Drive.

Other flow splits in this area include Guidici Ditch and Murray Gilbert Slough. While these flow splits do produce hazardous flooding for short reaches, they each ultimately become perched channels downstream of Schuler Lane. All flow that does not fit in the channel of these two ditches ultimately joins Selway Slough downstream of Schuler Lane.

Therefore, the total discharge on Lower Selway Slough is a composite of flow through the diversion structure, flow caused by the failure of the non-levee embankment on the left overbank of the Beaverhead River, and flow from Gilbert Ditch and Murray Gilbert Slough. **The total 1%-annual-chance flow on Lower Selway Slough is 484.71 cfs.**

3. Hydraulic Analysis and Results

Base level hydraulic 2-D modeling was performed using HEC-RAS, version 5.0.3. (Reference 3). Modeling inputs and results are described below.

3.1. Terrain Data

Terrain data was collected on April 18, 2013 for the entire study footprint area in the form of Light Detection and Ranging (LiDAR) points by Quantum Spatial (Reference 4). The LiDAR deliverables included a 1-meter resolution Digital Elevation Model (DEM) for the study area, which was used in the hydraulic model.

3.2. 2-D Flow Area

A 2-D flow area grid was for the entire area of Lower Selway Slough – an area of approximately 18 square miles. Typical grid cells were set with an average dimension of 25 feet by 25 feet. The grid was further refined using breaklines, to more appropriately account for and model topographic breaks on road embankments, significant channel banks, and other significant topographic features which had the likelihood of impacting hydraulic conditions.

At road crossings, it was assumed that any hydraulic structure that may exist is either insignificant or will be blocked during a flood event. This conservative assumption is appropriate given that the structures that we do have survey data for, at the downstream end of Upper Selway Slough (which is covered by detailed modeling as a part of the Beaverhead River study) are typically culverts ranging in diameter from 18 inches to 24 inches. Structures of this size are not likely to carry a significant portion of the total flow during flood events.

3.3. Manning's n values

Manning's 'n' was set uniformly at a value of 0.045 for the entire 2-D flow area. This value is indicative of winding channels with some pools and shoals, and some weeds and stones, as well as overbank areas containing broad pasture area with occasional brush or trees.

3.4. Boundary Conditions

Two boundary condition lines were set for the project: a flow hydrograph inflow and a normal depth outflow. The flow hydrograph at the upper end of the reach is set to the 1%-annual-chance flow of 484.71 cfs at all timesteps, representing the discharge calculated in the Beaverhead River and Tributaries Hydraulic Analysis. The normal depth boundary condition at the downstream end of the reach is set to a slope of 0.001, which is the measured slope of the channel at the downstream end.

3.5. Model Setup

The model used a three-second timestep, with a 48-hour total simulation time. The full momentum equation set is used.

3.6. Model Results and Mapping

The model runs and appears to produce reasonable results throughout the study reach. The floodplain is broad in many areas, with many numerous primary and secondary flowpaths throughout. This is expected and reasonable given the underlying terrain and the fact that the channel is undersized relative to the magnitude of flow during the 1%-annual-chance event.

The resultant floodplain was exported from the model and smoothed and minimally refined using automated processes. Workmaps containing these "raw" floodplain results are included for informational benefit in Appendix A. We anticipate that we will manually refine the mapping further, to create a product suitable for Zone A mapping, during the next phase of this project.

4. Floodplain Mapping

FEMA's KSS and many of FEMA's technical guidance documents were consulted to ensure the mapping meets mandatory requirements necessary to map the results of this study on Beaverhead County's FIRM panels in the future. To create this data set so that it can be incorporated into the Beaverhead County DFIRM, the following guidance documents were used: Data Capture Standards Technical Reference (Reference 5), FIRM Panel Technical Reference (Reference 6), Metadata (Reference 7); Physical Map Revision (PMR) (Reference 8); Flood Insurance Rate Map (FIRM) Database (Reference 9); and, Flood Insurance Rate Map (FIRM) Graphics (Reference 10).

4.1. Floodplain Work Maps

Floodplain mapping was performed using results from the hydraulic analysis and the 2013 Quantum Spatial LiDAR. The workmaps are included in **Appendix A**, and they show the locations of the 1-percent-annual-chance flood event floodplain delineations. Geo-RAS was also used to produce rough floodplain delineations. These rough delineations were manually smoothed and adjusted to ensure reasonable floodplain delineations and to account for hydraulic features such as backwater or islands.

At many locations, engineering judgment was critical in determining the appropriate floodplain boundaries. Some of the mapping decisions made in certain areas include:

- All small islands are removed from the mapping – this is a standard FEMA practice to account for uncertainty around the islands, and because many islands are not visible at the FIRM scale. Large islands in the floodplain where the average ground surface is less than 0.5 foot above the BFE were also not mapped.

- Hydraulically disconnected areas are not mapped.

4.2. Tie-In Locations

No tie-in to effective SFHAs are necessary in this area – the mapping along the Selway Slough was revised to tie into the Beaverhead River and Splits revised mapping.

4.3. Changes Since Last FIRM Mapping – 1-Percent-Annual-Chance Flood Event Comparison

There was no effective mapping along this reach of Selway Slough, hence The Changes Since Last FIRM (CSLF) dataset was not created for this submittal.

5. References

1. Michael Baker International, Beaverhead River and Tributaries, Hydraulic Analysis Report, draft dated November 2017.
2. Pioneer Technical Services Inc., Beaverhead River Hydrologic Analysis – Beaverhead River Floodplain Study. April 2017.
3. U.S. Army Corps of Engineers, Hydraulic Engineering Center, HEC-RAS River Analysis System, Version 5.0.3. Davis, CA, September 2016.
4. Quantum Spatial, Dillon AOI, Beaverhead County LiDAR Technical Data Report, May 27, 2016.
5. Federal Emergency Management Agency, Technical Reference: Data Capture Standards, February 2018.

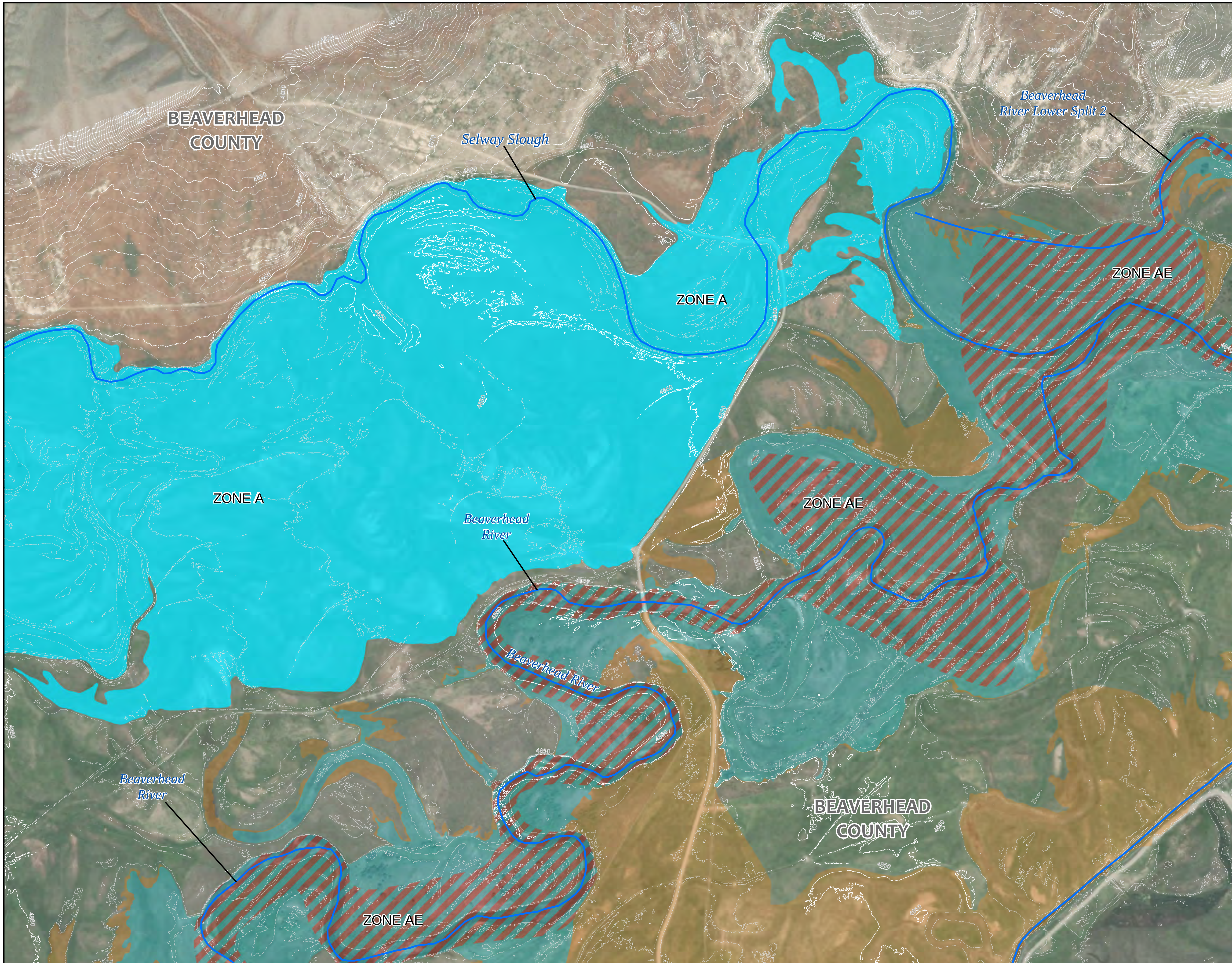
6. Federal Emergency Management Agency, Technical Reference: Flood Insurance Rate Map (FIRM) Panel, November 2016.
7. Federal Emergency Management Agency, Guidance for Flood Risk Analysis and Mapping: Metadata, May 2017.
8. Federal Emergency Management Agency, Guidance for Flood Risk Analysis and Mapping: Physical Map Revision (PMR), November 2016.
9. Federal Emergency Management Agency, Guidance for Flood Risk Analysis and Mapping: Flood Insurance Rate Map (FIRM) Database, February 2018.
10. Federal Emergency Management Agency, Guidance for Flood Risk Analysis and Mapping: Flood Insurance Rate Map (FIRM) Graphics, May 2016.
11. Federal Emergency Management Agency, Guidance for Flood Risk Analysis and Mapping: Changes Since Last FIRM, February 2018.

Appendix A.

Draft Floodplain Workmaps

SELWAY SLOUGH HYDRAULIC WORKMAP

October 30, 2018



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- Study Profile Baseline
- Proposed 1-Percent-Annual Chance Event
- (Beaverhead Study) Proposed Floodway
- (Beaverhead Study) Proposed 1-Percent-Annual Chance Event
- (Beaverhead Study) Proposed 0.2-Percent-Annual Chance Event
- 10 FT Contour
- 2 FT Contour
- Interstate
- Highway
- Railroad
- Political Area

0 100 200 300 400 Feet

1 inch = 400 feet

DATA FRAME PROPERTIES:
Coordinate System: NAD 1983 2011 StatePlane Montana FIPS 2500 Ft Int
Projection: Lambert Conformal Conic
Datum: NAD 1983 2011
Vertical Datum: NAVD 88
Units: Feet

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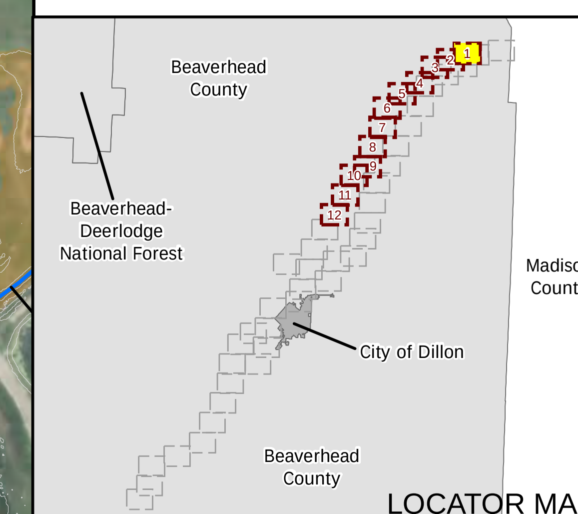

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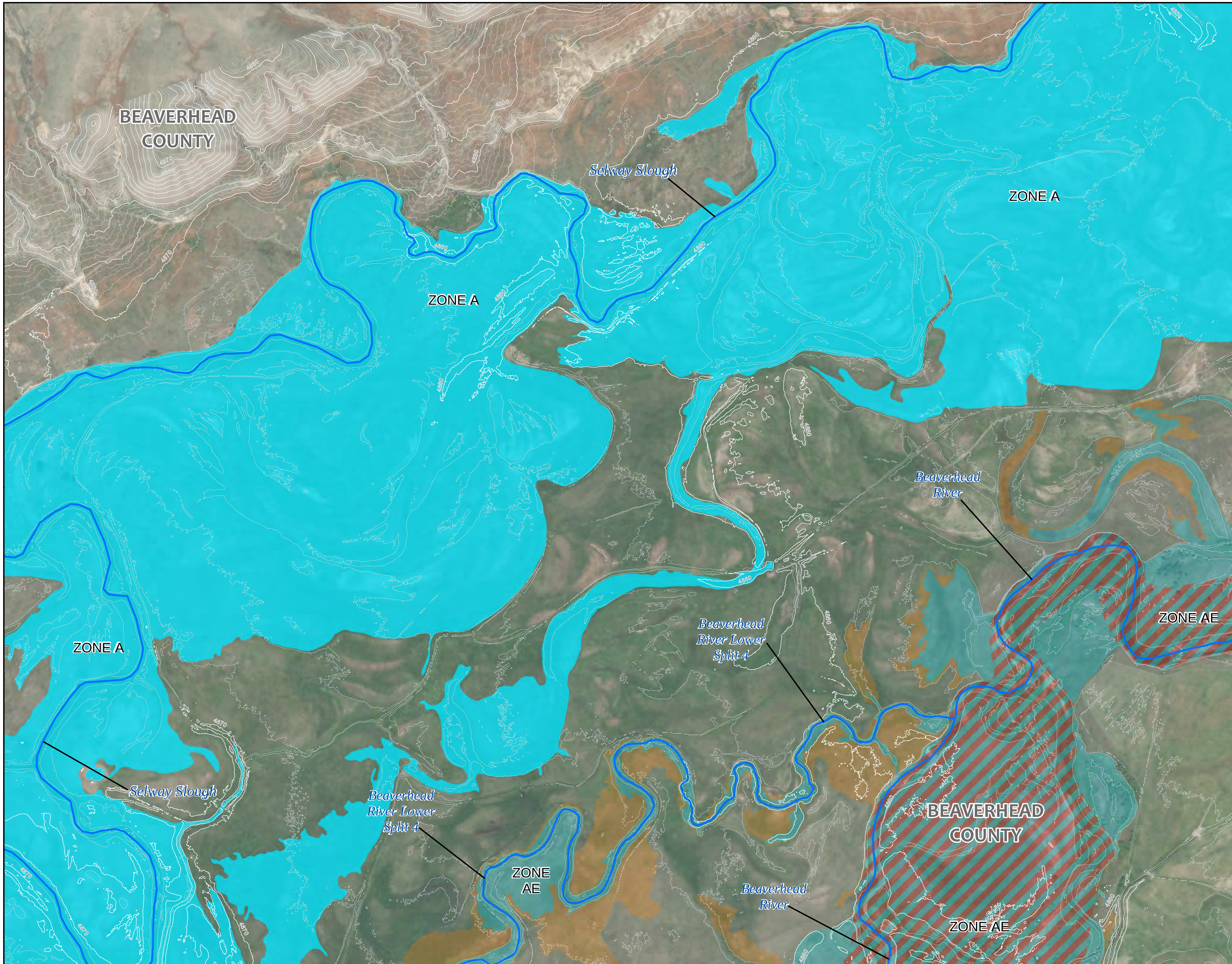

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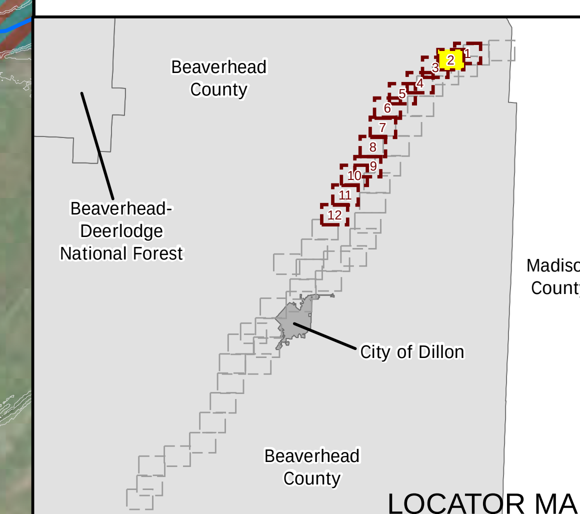

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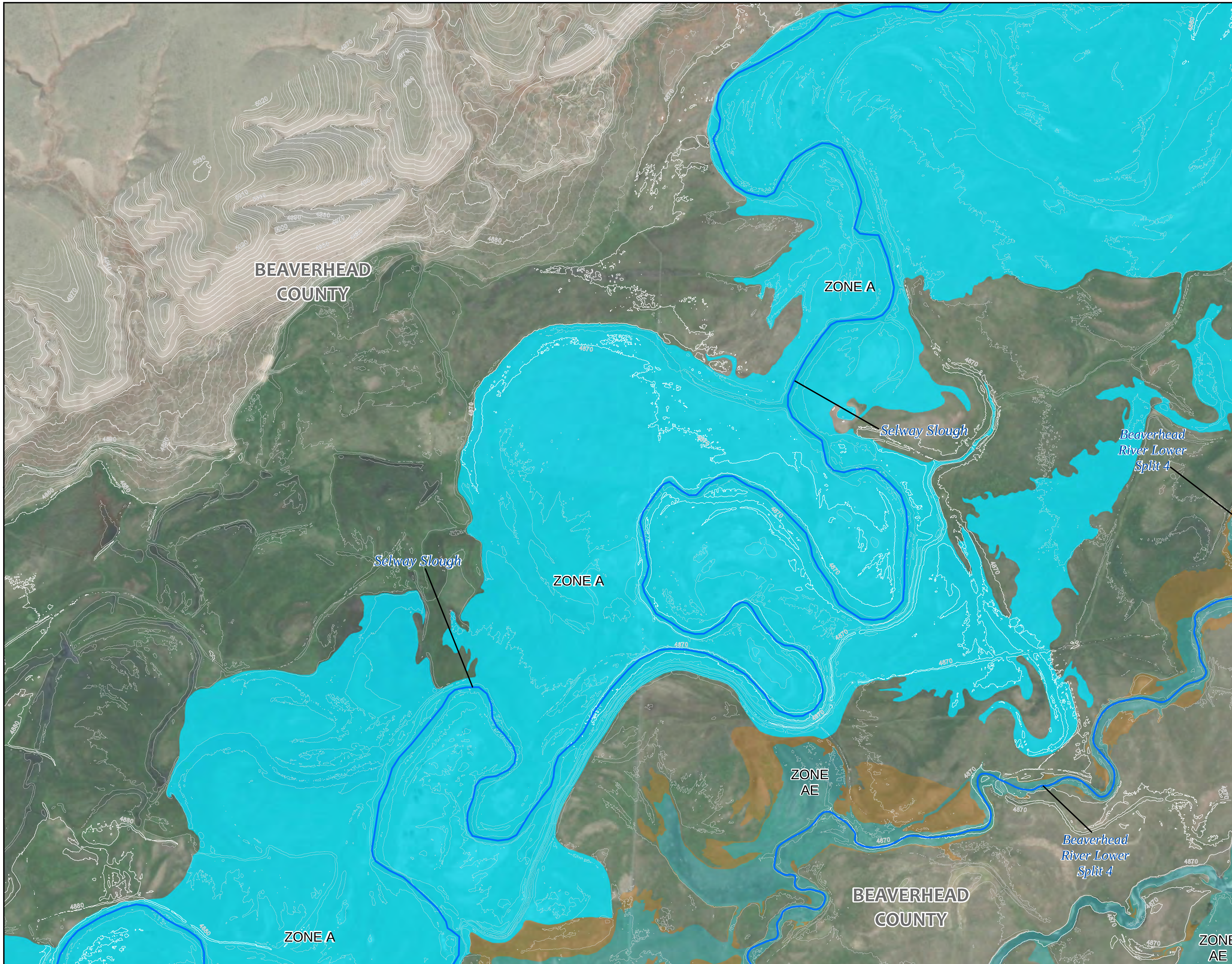

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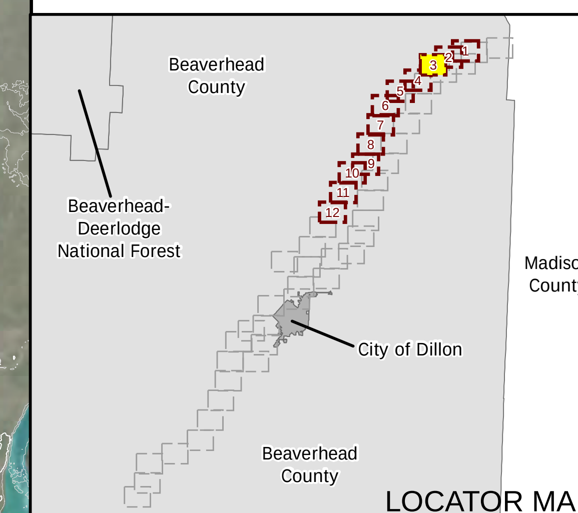

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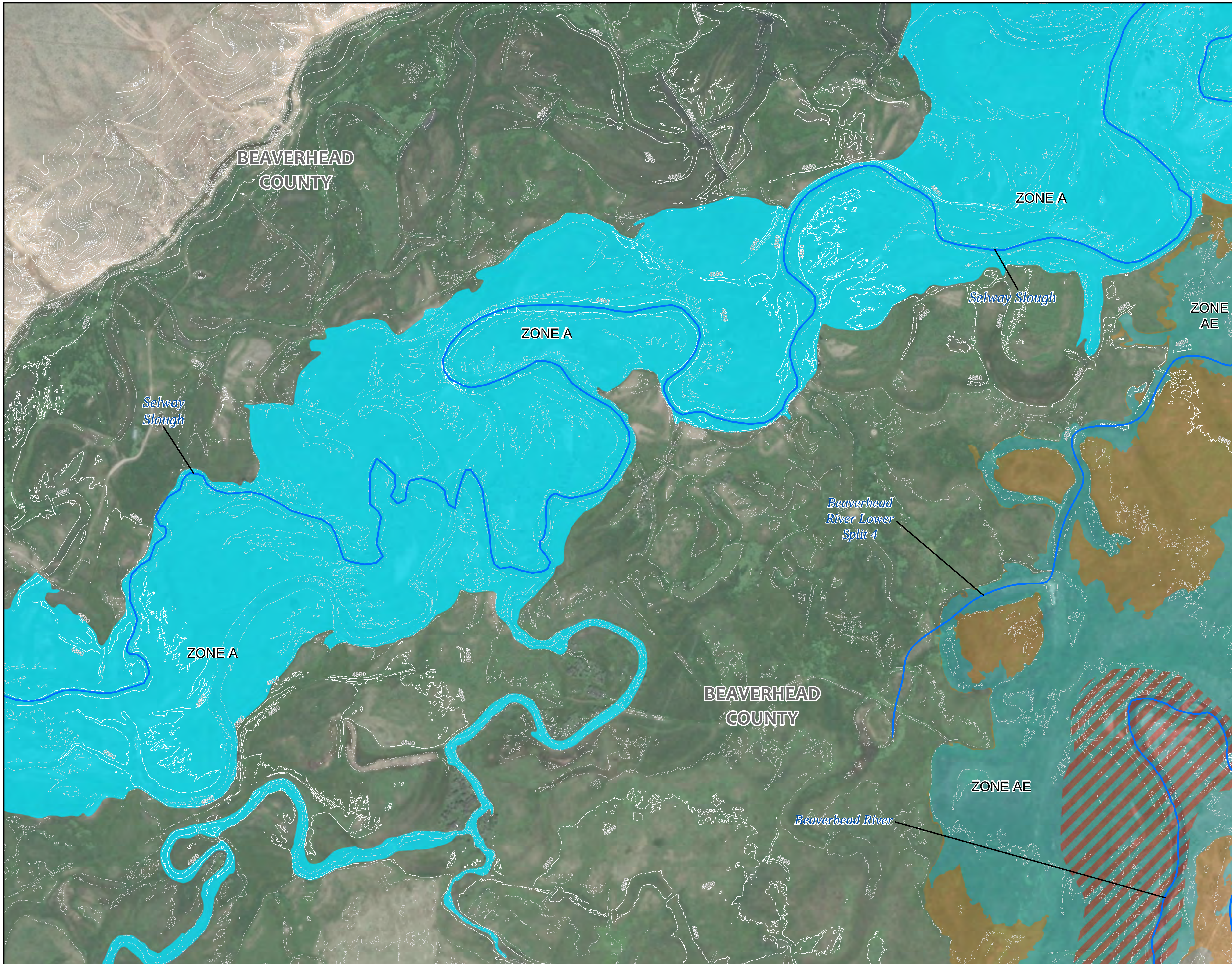

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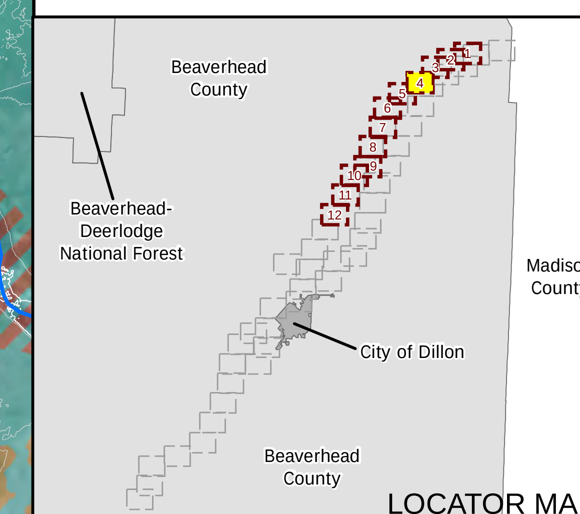

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SELWAY SLOUGH HYDRAULIC WORKMAP

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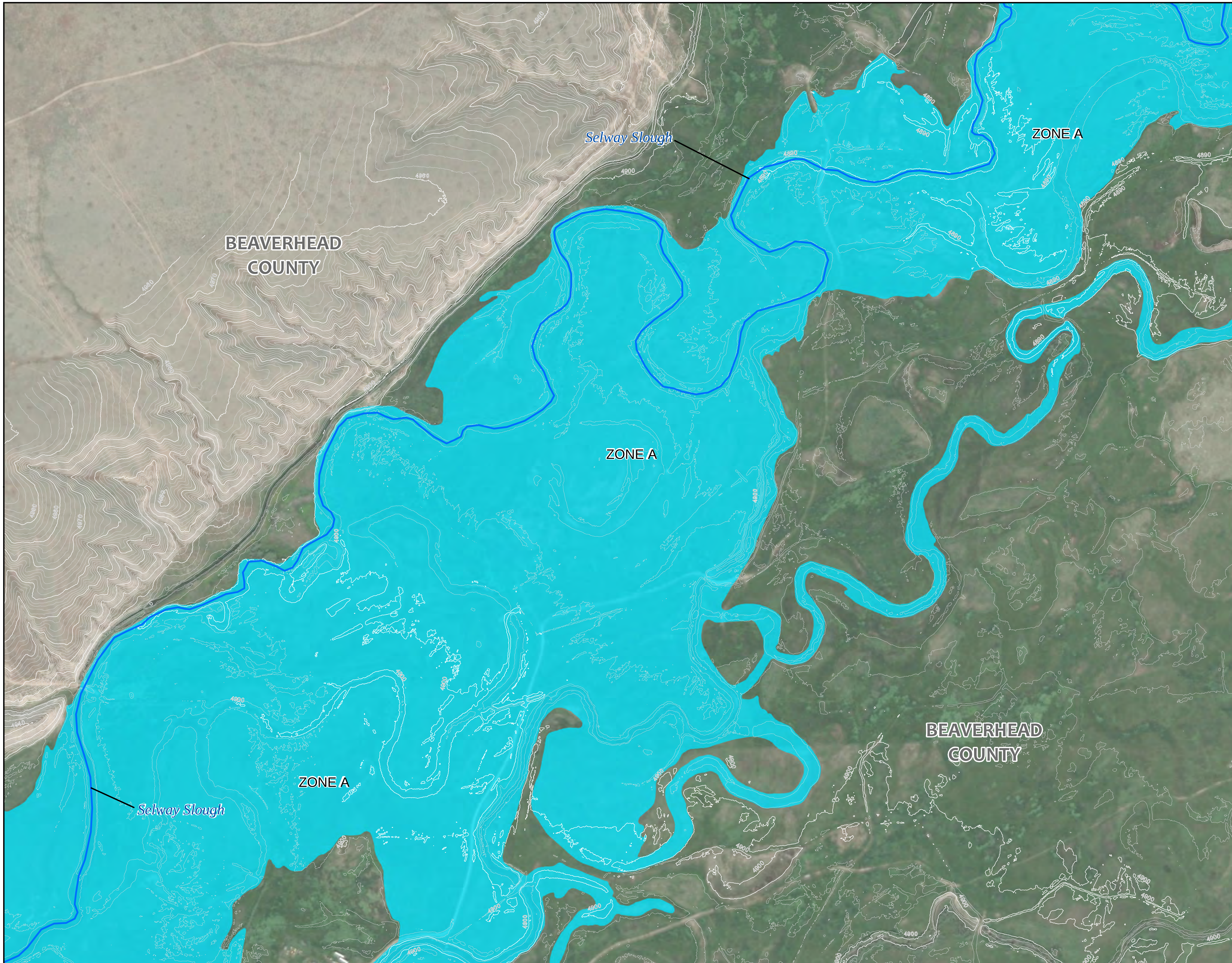

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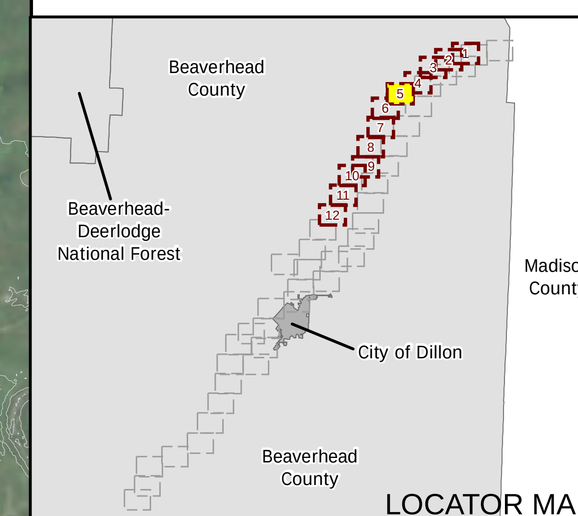

LOCATOR MAP

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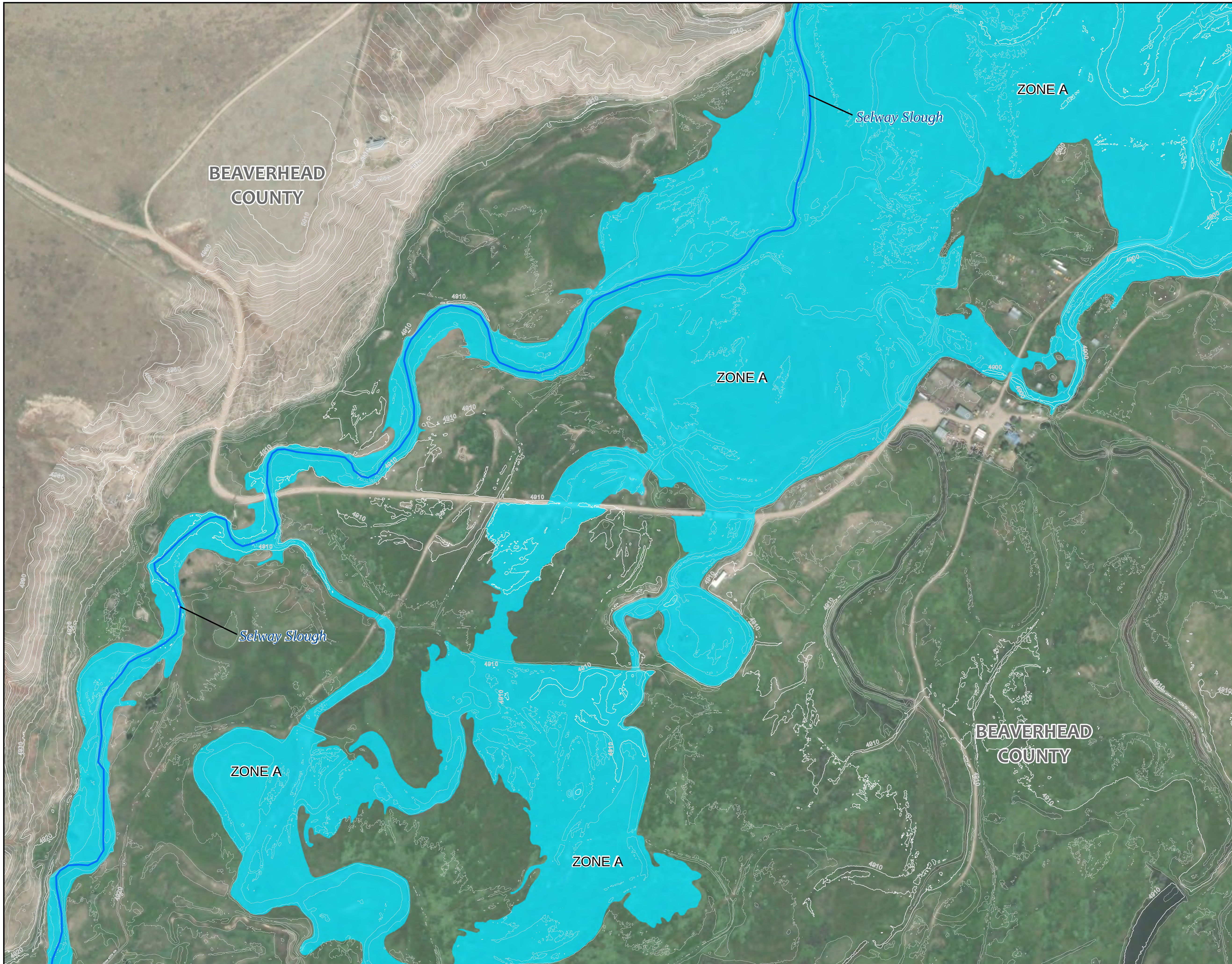

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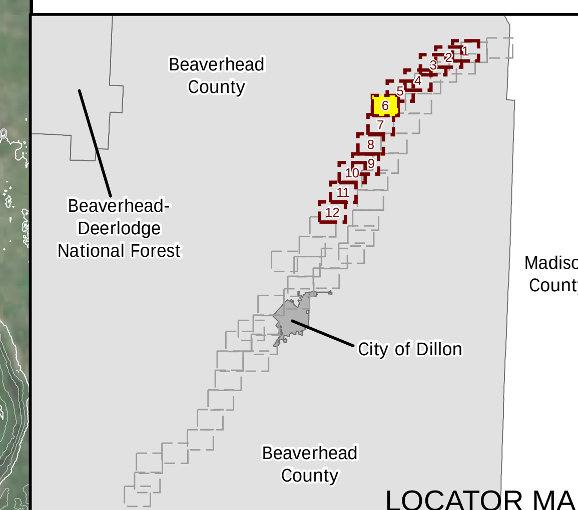

Selway Slough 6

SELWAY SLOUGH HYDRAULIC WORKMAP

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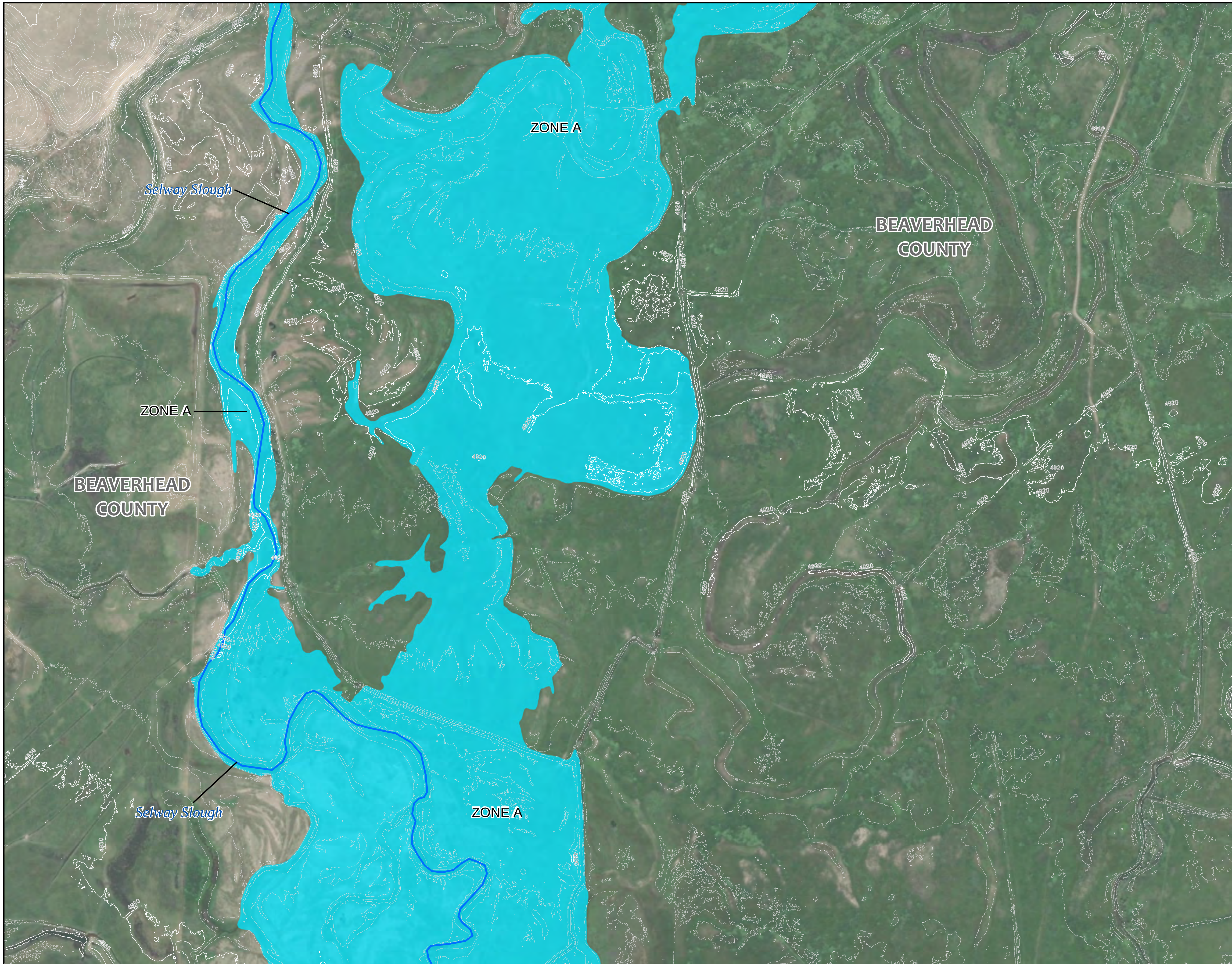

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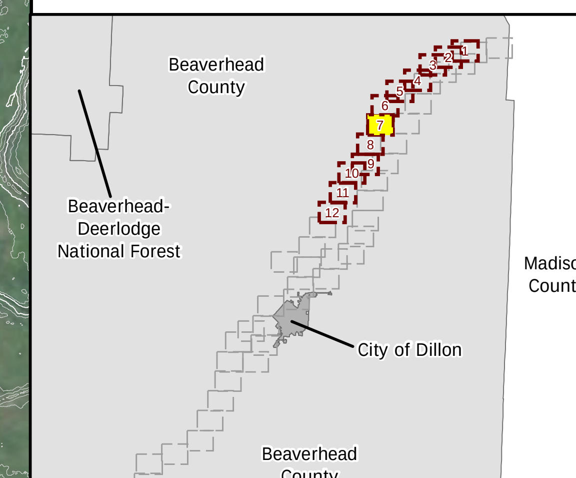

LOCATOR MAP

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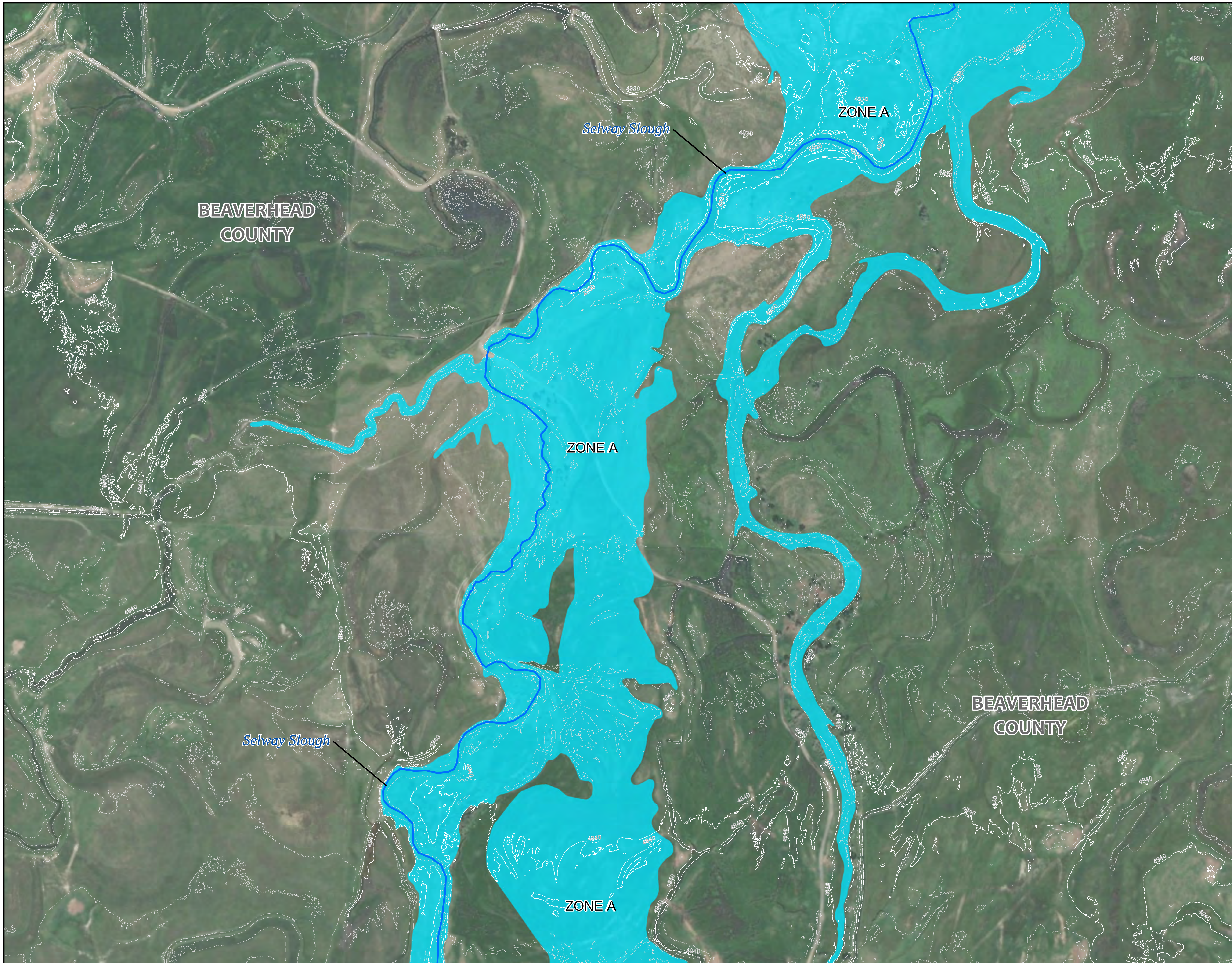

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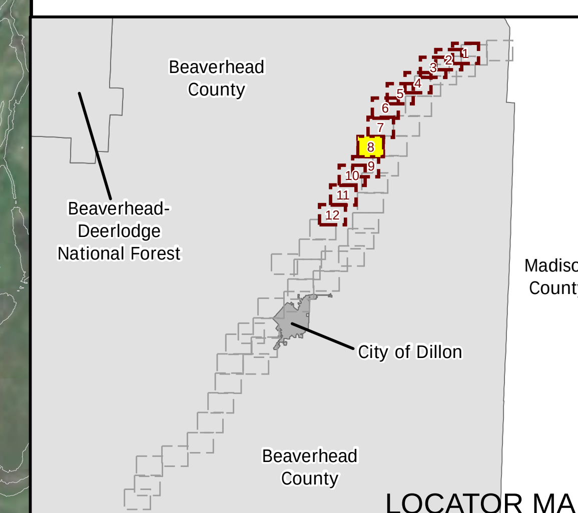

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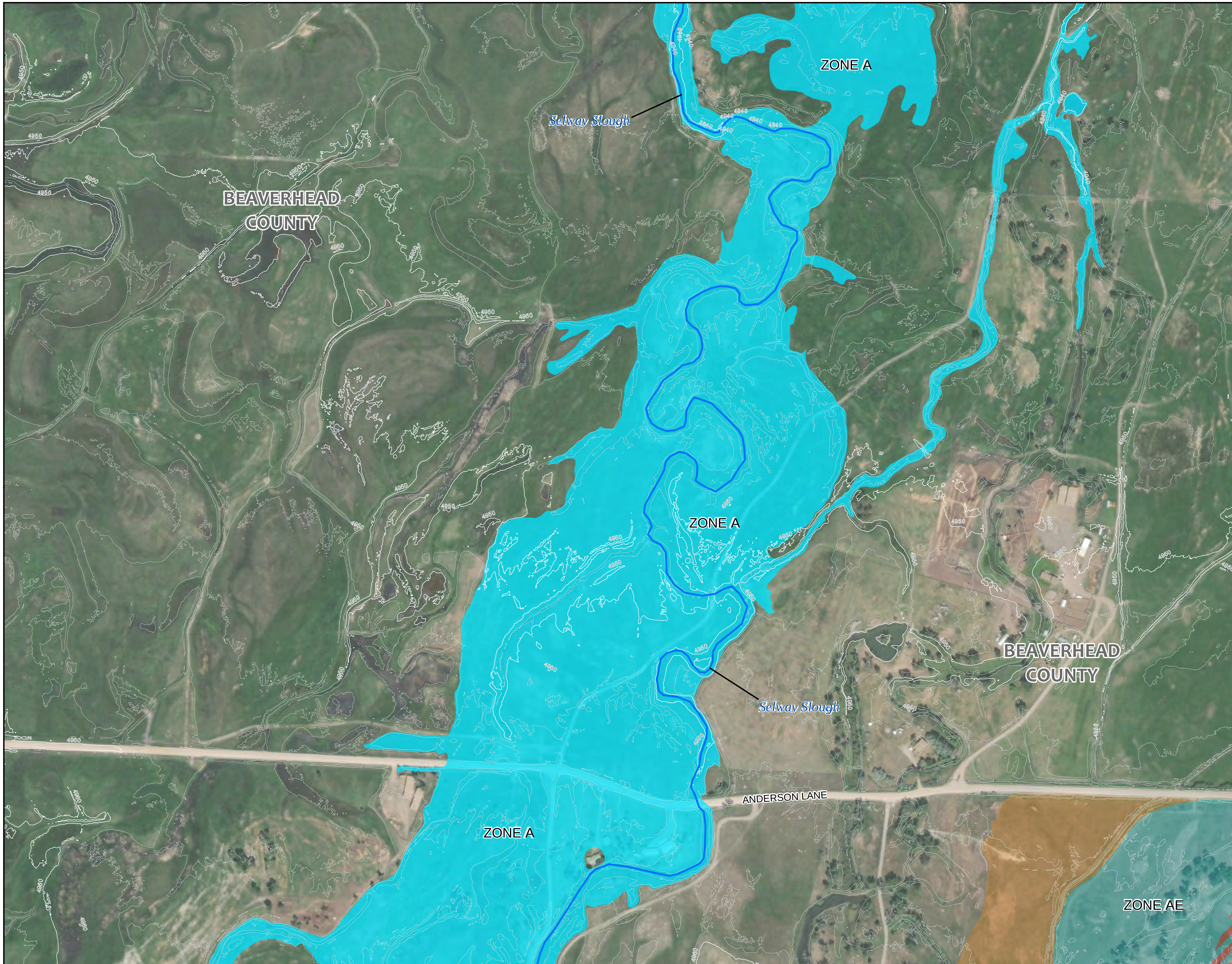

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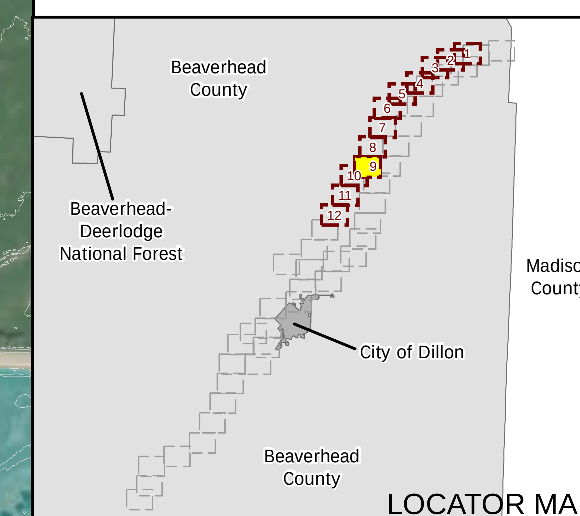

Selway Slough 9

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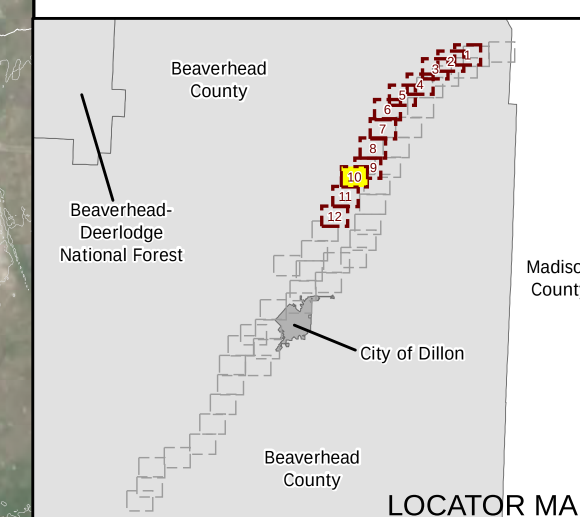

Selway Slough 10

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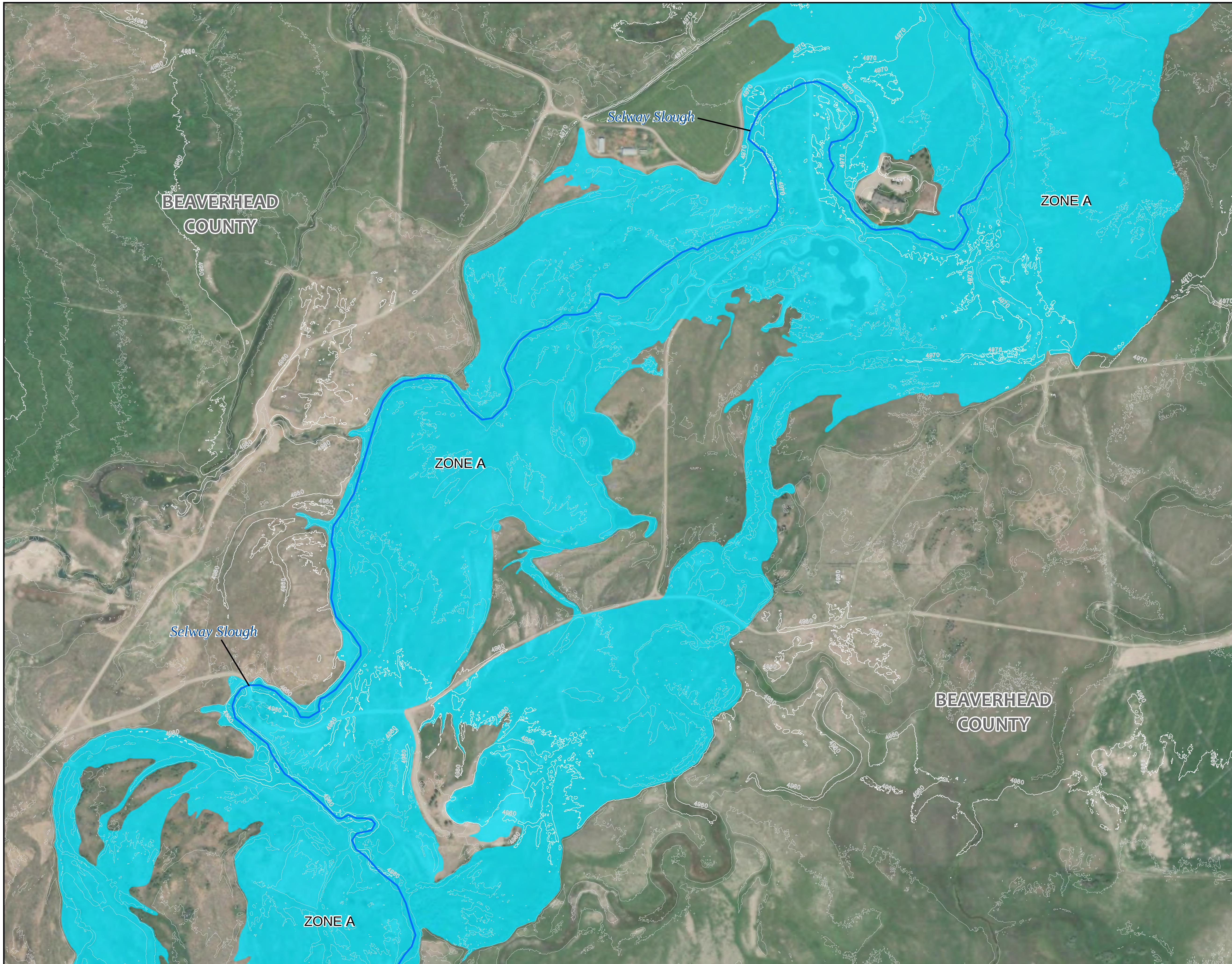

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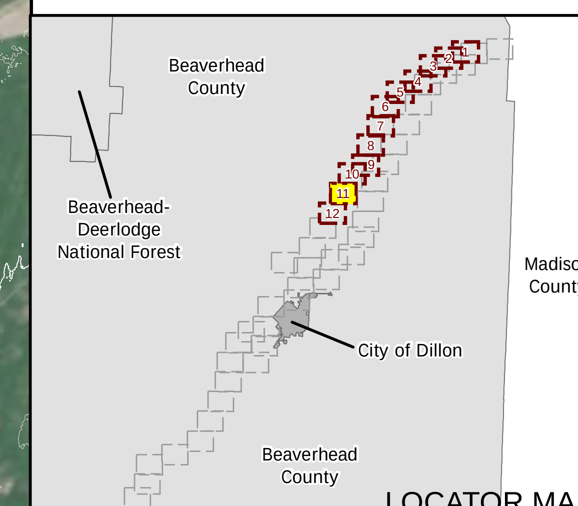

LOCATOR MAP

Selway Slough 11

SELWAY SLOUGH HYDRAULIC WORKMAP

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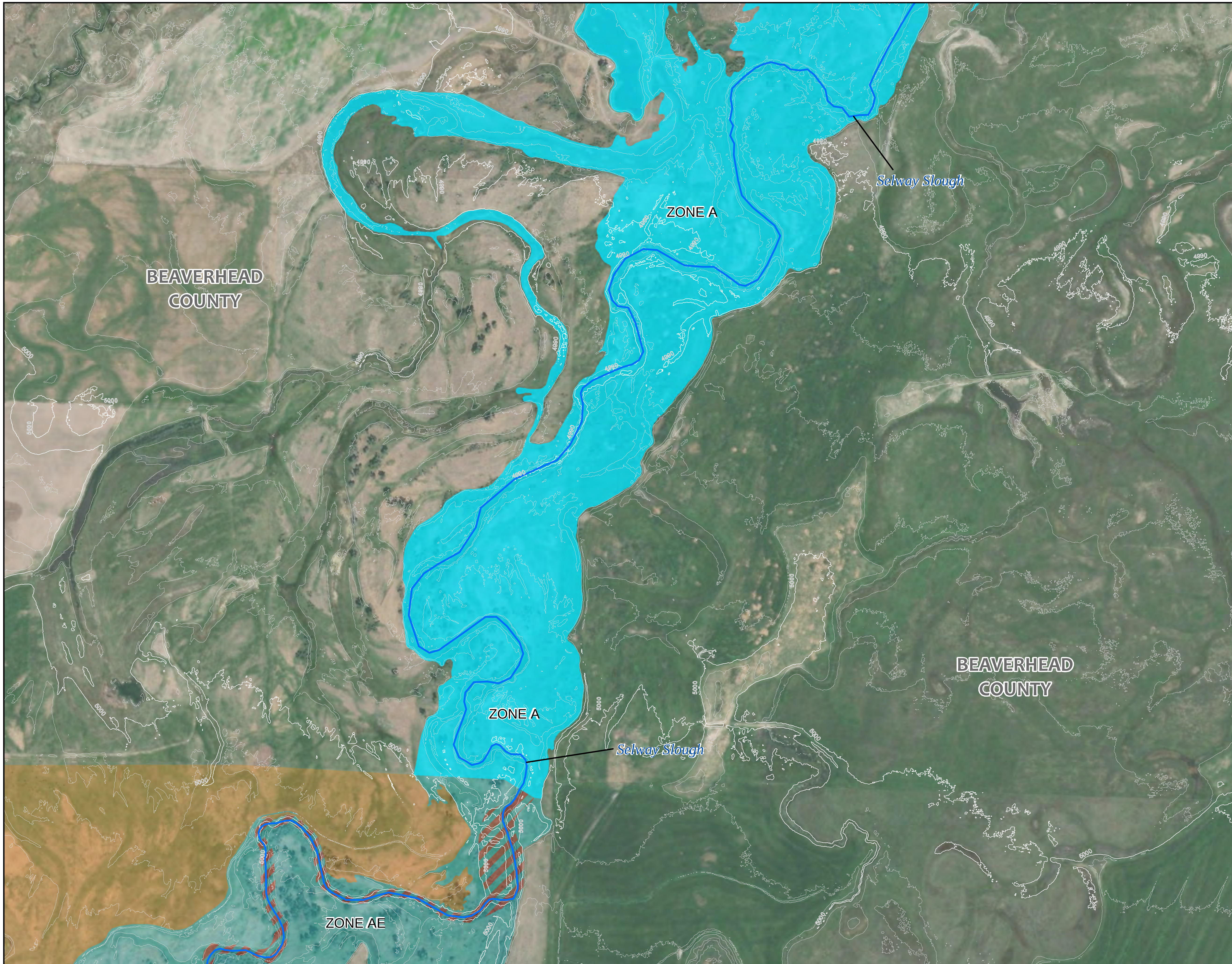

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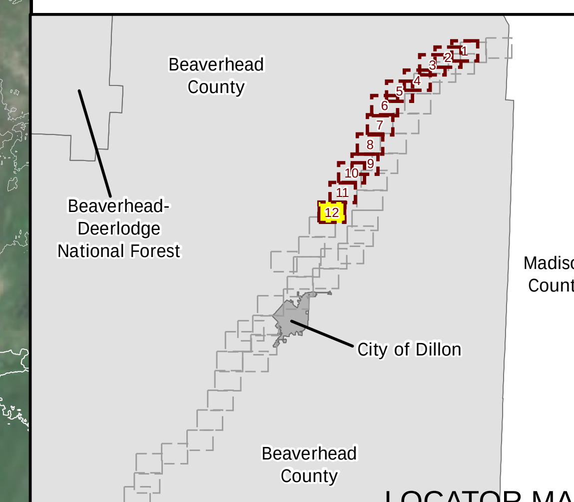

LOCATOR MAP

Selway Slough 12

Appendix B.

FIS TEXT

Table 1: Flooding Sources Included in this FIS Report

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Lower Selway Slough	Beaverhead County and Incorporated Areas	Confluence with Beaverhead River	Downstream limit of detailed study of Selway Slough	10020002	18	N	A	October 2018

Table 2: Summary of Hydrologic and Hydraulic Analyses

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Lower Selway Slough	Confluence with Beaverhead River	Downstream Limit of Detailed Study of Selway Slough	HEC-RAS	HEC-RAS	October 2018	A	Base Level 2-D Analysis

Table 3: Roughness Coefficients

Flooding Source	Channel “n”	Overbank “n”
Lower Selway Slough	0.045	0.045

Table 4: Base Map Sources

Data Type	Data Provider	Data Date	Data Scale	Data Description
Digital Orthophoto	USDA/NAIP	2016	1-meter	Orthophotography
Base map files	Montana Geographic Information Clearinghouse	2016	*	Political boundaries, rivers, lakes, streams, in digital format

Table 5: Summary of Topographic Elevation Data used in Mapping

Community	Flooding Source	Source for Topographic Elevation Data			
		Description	Scale	Contour Interval	Citation
Beaverhead County	Lower Selway Slough	Airborne LiDAR Survey	1-meter	0.5-m	Quantum Spatial, Inc.; May 2016

Table 29: Summary of Contracted Studies Included in this FIS Report

Flooding Source	FIS Report Dated	Contractor	Number	Work Completed Date	Affected Communities
Lower Selway Slough	TBD	Michael Baker International	2016 – 01 (Mapping Activity Statement Number)	October 2018	Beaverhead County

Table 6: Bibliography and References

Citation in this FIS	Publisher/ Issuer	*Publication Title,* "Article," Volume, Number, etc.	Author/ Editor	Place of Publication	Publication Date/ Date of Issuance	Link
TBD	MT DNRC	*Draft Beaverhead River Hydrologic Analysis*	Pioneer Technical Services		April 2017	
TBD	MT DNRC	*Dillon AOI, Beaverhead County LiDAR Technical Data Report*	Quantum Spatial		May 2016	
TBD	MT DNRC	*Lower Selway Slough Hydraulic Analysis and Mapping Report*	Michael Baker International		October 2018	